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(54) **METHOD AND APPARATUS FOR THE TRICHOTOMOUS IDENTIFICATION OF MORBIDITY, MORTALITY AND SURVIVAL WITHOUT NEW MORBIDITY FROM INTENSIVE CARE**

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(57) **ABSTRACT**

A method for determining a patient risk in according with the present application comprises obtaining patient information for a patient admitted to a medical facility, the patient information including patient descriptive information, diagnostic information and physiological information, determining a patient score according to the physiological information, and simultaneously determining, by circuitry, a patient morbidity risk and a patient mortality risk for the patient according the patient descriptive information, the diagnostic information and the patient score. The determining of the patient score according to the physiological information may further include identifying a numerical value for the patient descriptive information, the diagnostic information and the physiological information, and determining the patient score by computing the numerical values.

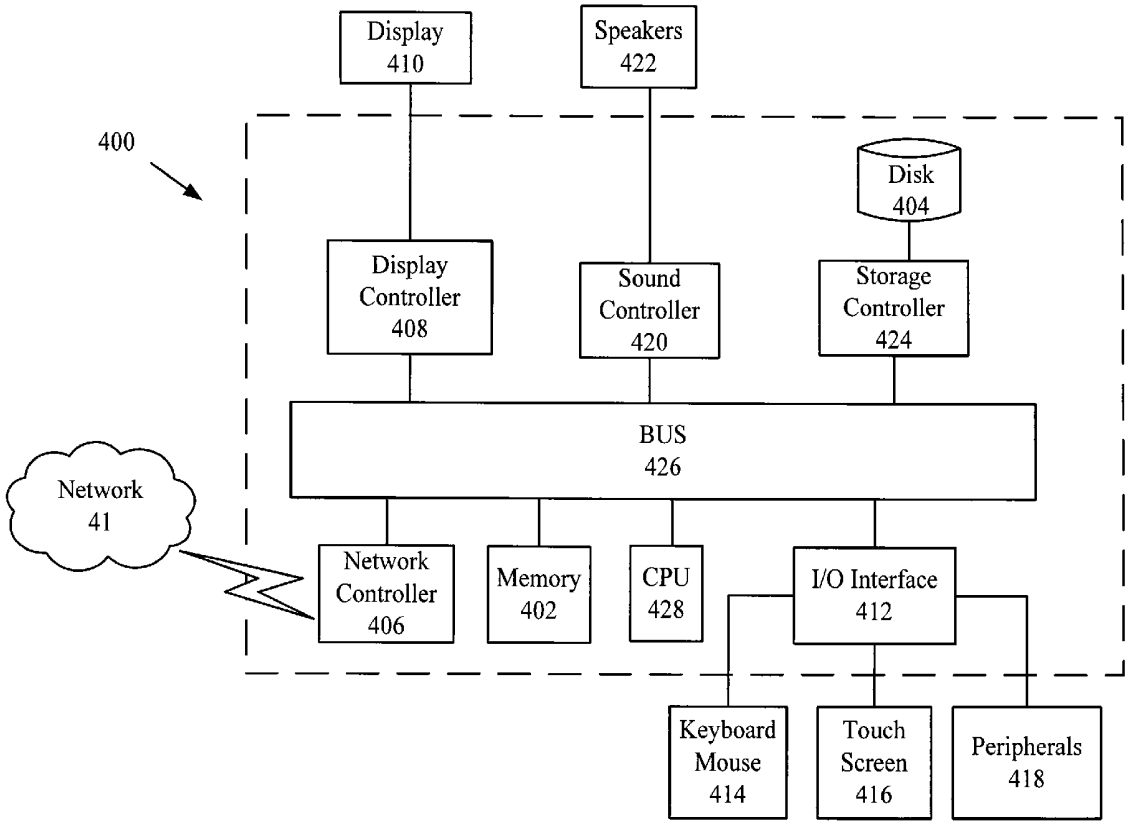


FIG. 1

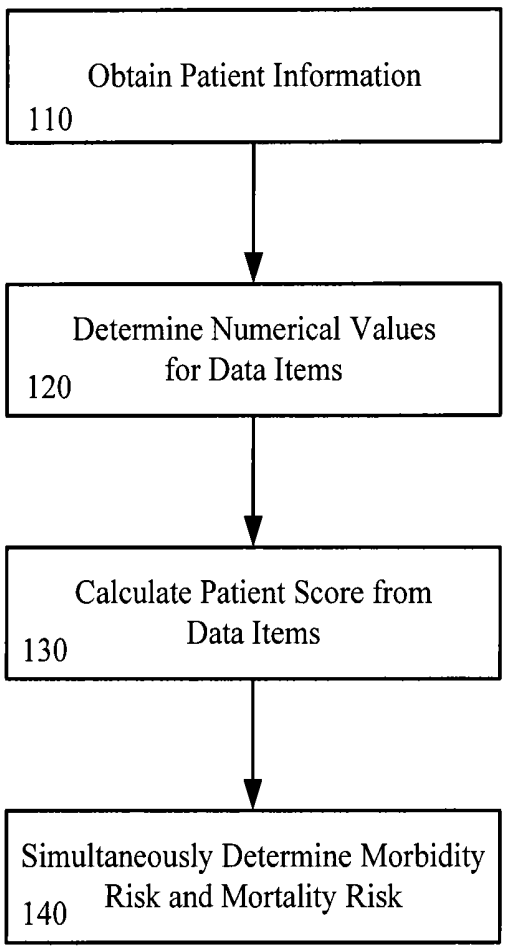

Obtain Patient Information
110
Determine Numerical Values for Data Items
120
Calculate Patient Score from Data Items
130
Simultaneously Determine Morbidity Risk and Mortality Risk
140

FIG. 2

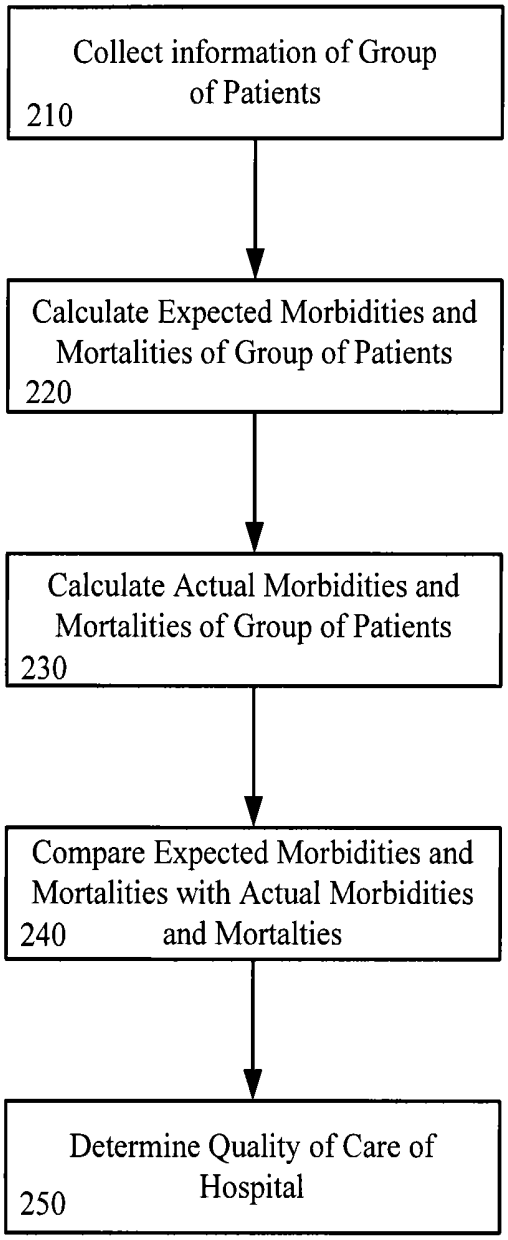
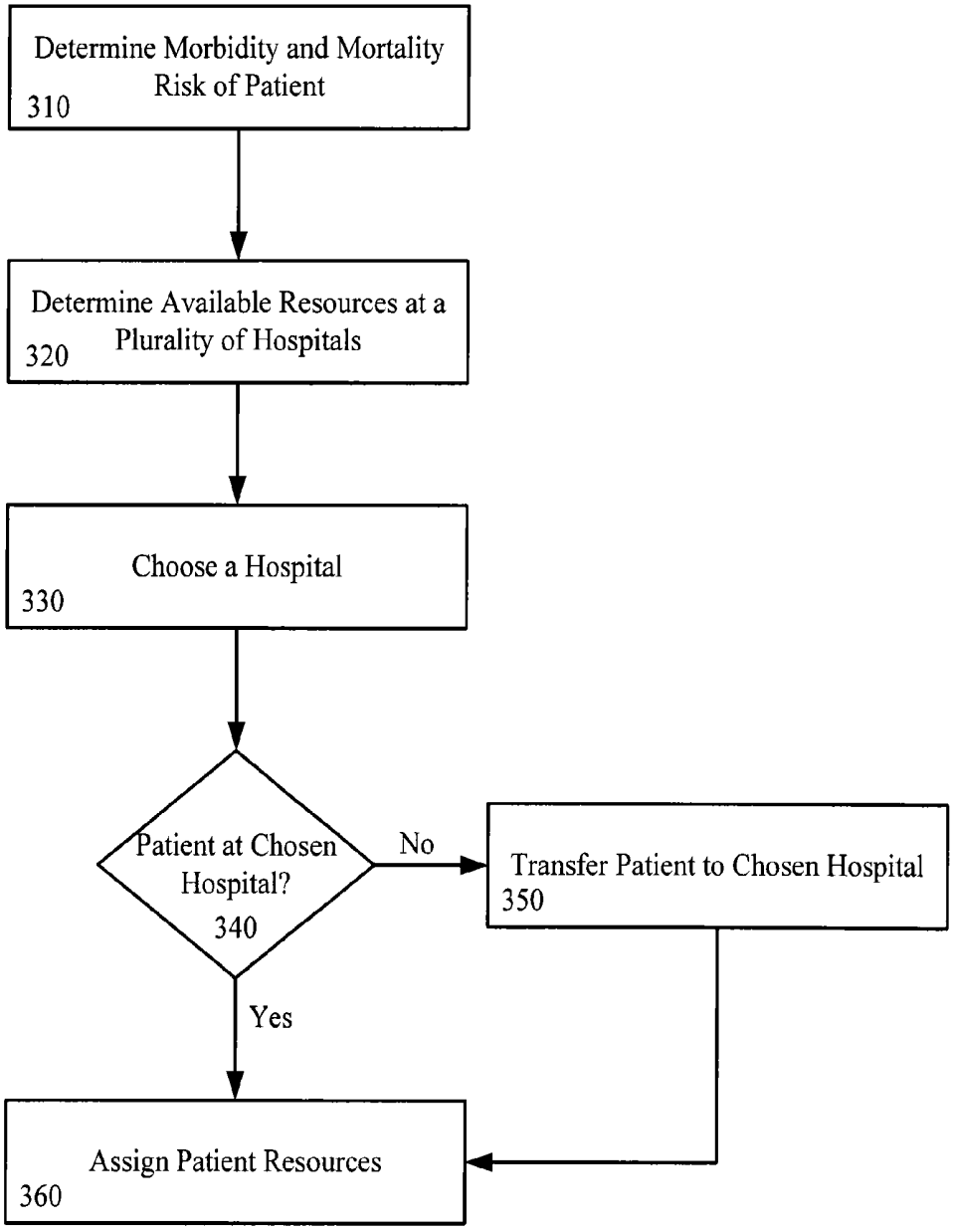

Collect information of Group of Patients
210
Calculate Expected Morbidities and Mortalities of Group of Patients
220
Calculate Actual Morbidities and Mortalities of Group of Patients
230
Compare Expected Morbidities and Mortalities with Actual Morbidities and Mortalties
240
Determine Quality of Care of Hospital
250

FIG. 3


Determine Morbidity and Mortality Risk of Patient
310
Determine Available Resources at a Plurality of Hospitals
320
Choose a Hospital
330
Patient at Chosen Hospital?
340
No
Transfer Patient to Chosen Hospital
350
Yes
Assign Patient Resources
360

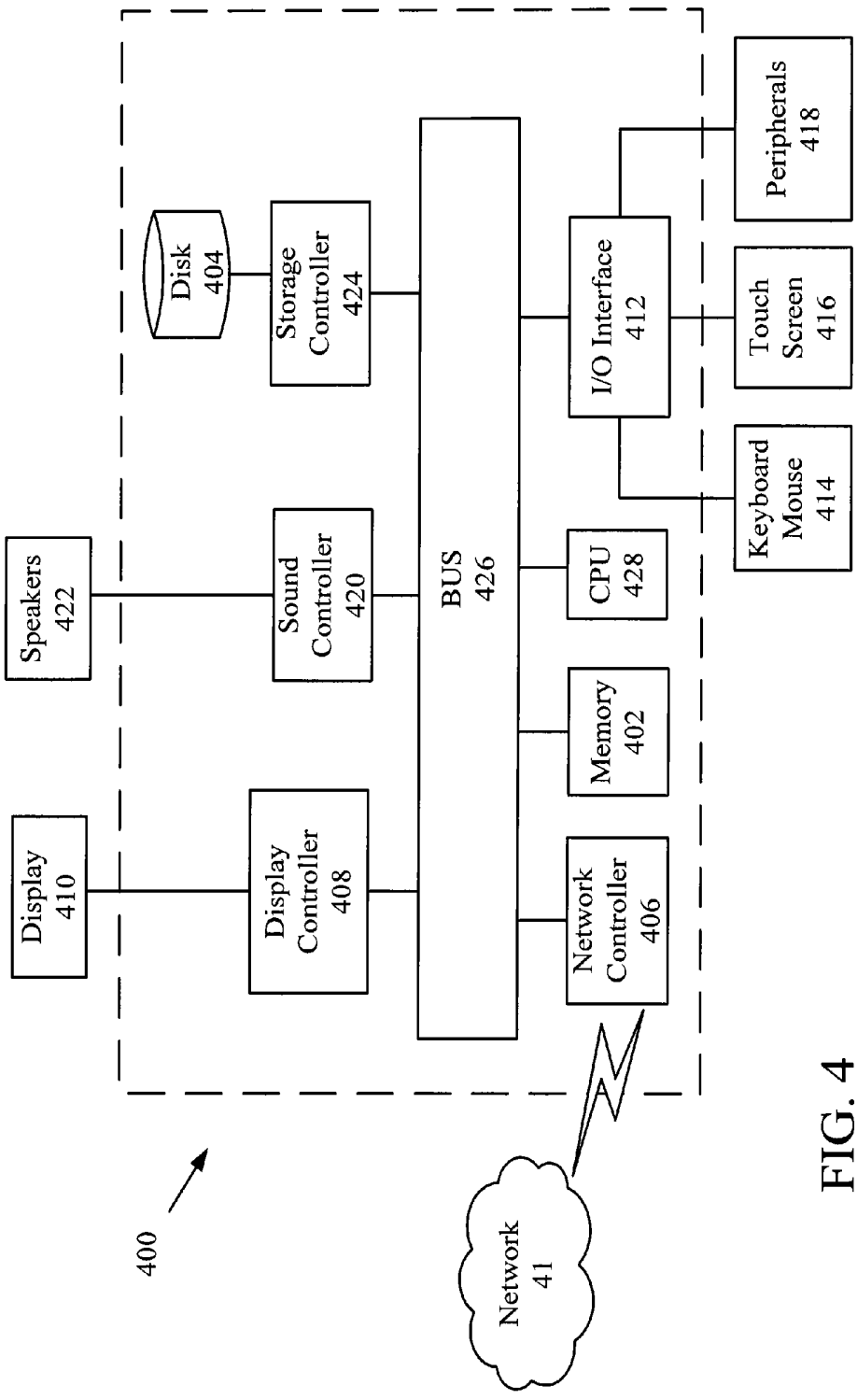

400
Network 41
Display 410
Speakers 422
Disk 404
Display Controller 408
Sound Controller 420
Storage Controller 424
Network Controller 406
Memory 402
BUS 426
CPU 428
I/O Interface 412
Keyboard Mouse 414
Touch Screen 416
Peripherals 418

FIG. 4

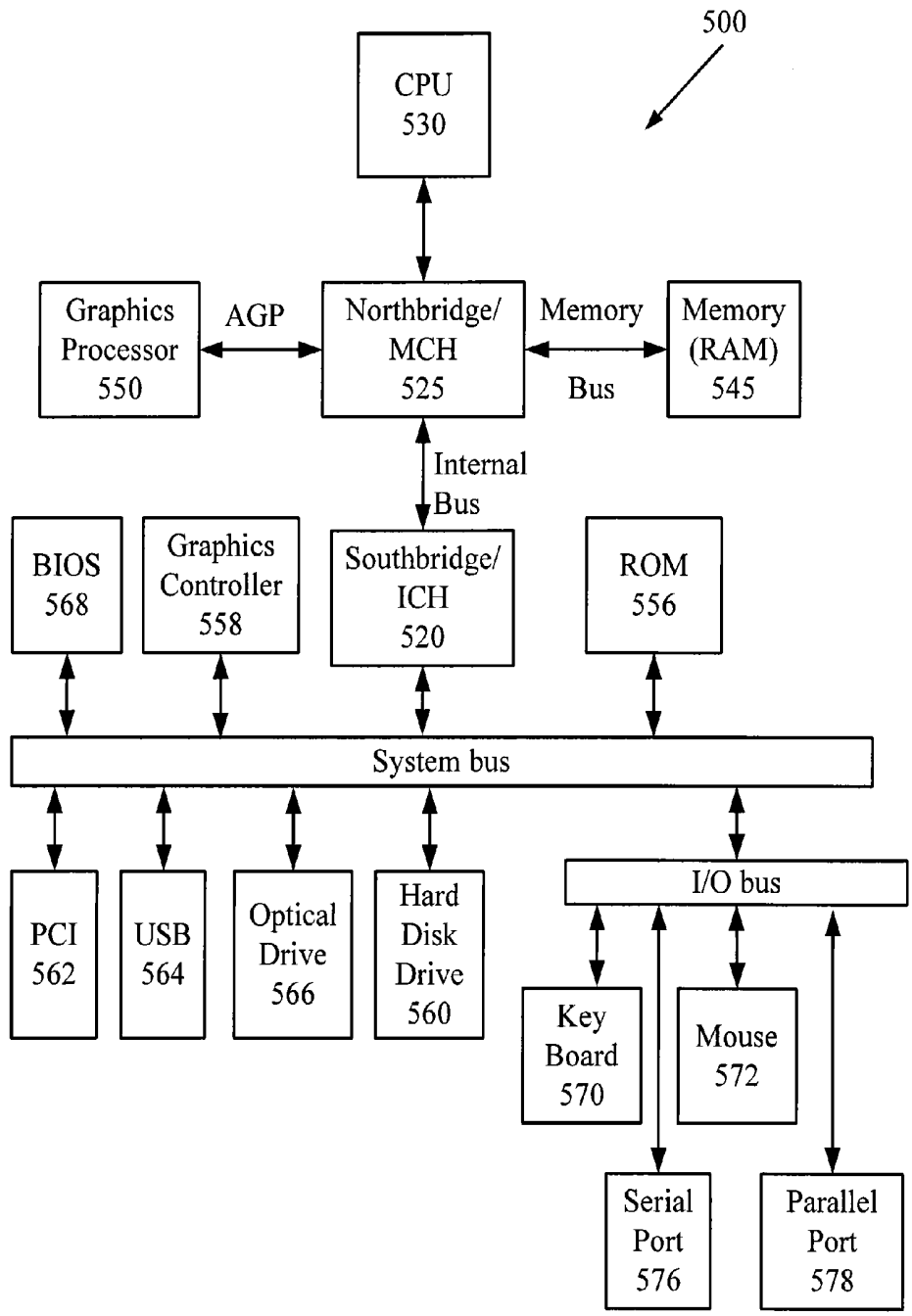

500
CPU
530
Graphics
Processor
550
AGP
Northbridge/
MCH
525
Memory
Bus
Memory
(RAM)
545
Internal
Bus
BIOS
568
Graphics
Controller
558
Southbridge/
ICH
520
ROM
556
System bus
PCI
562
USB
564
Optical
Drive
566
Hard
Disk
Drive
560
I/O bus
Key
Board
570
Mouse
572
Serial
Port
576
Parallel
Port
578

FIG. 5

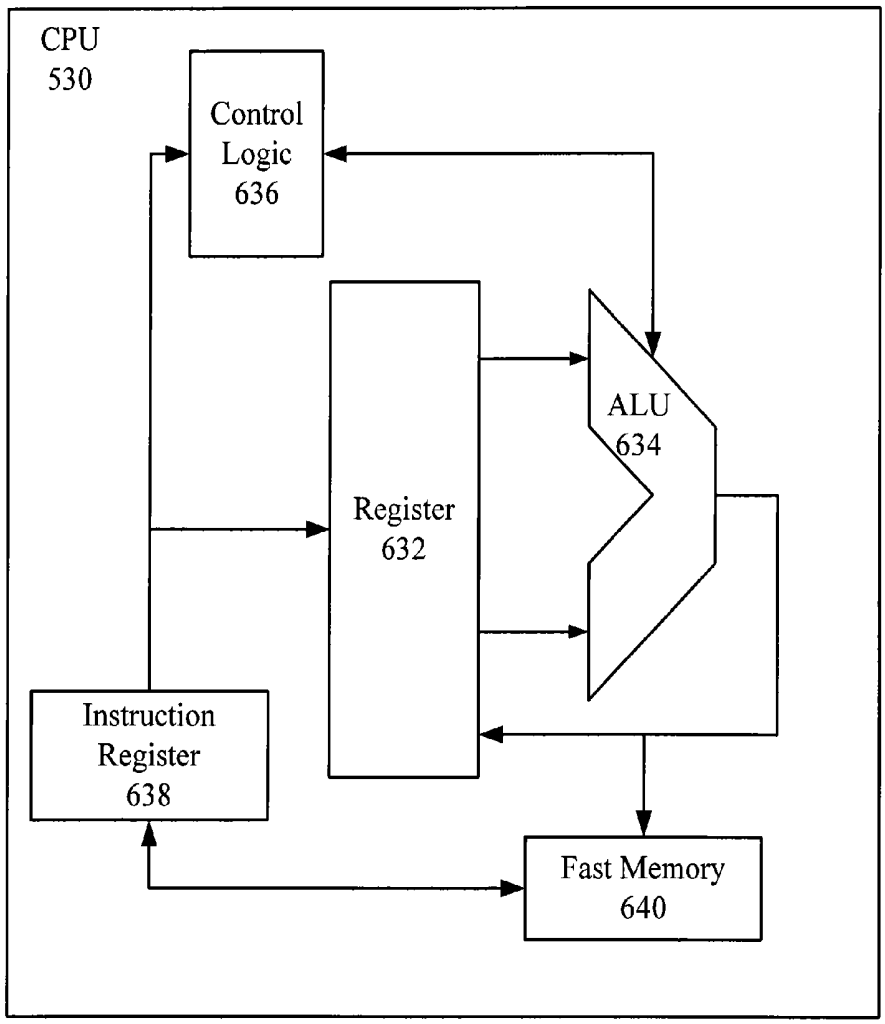

CPU
530
Control
Logic
636
ALU
634
Register
632
Instruction
Register
638
Fast Memory
640

FIG. 6

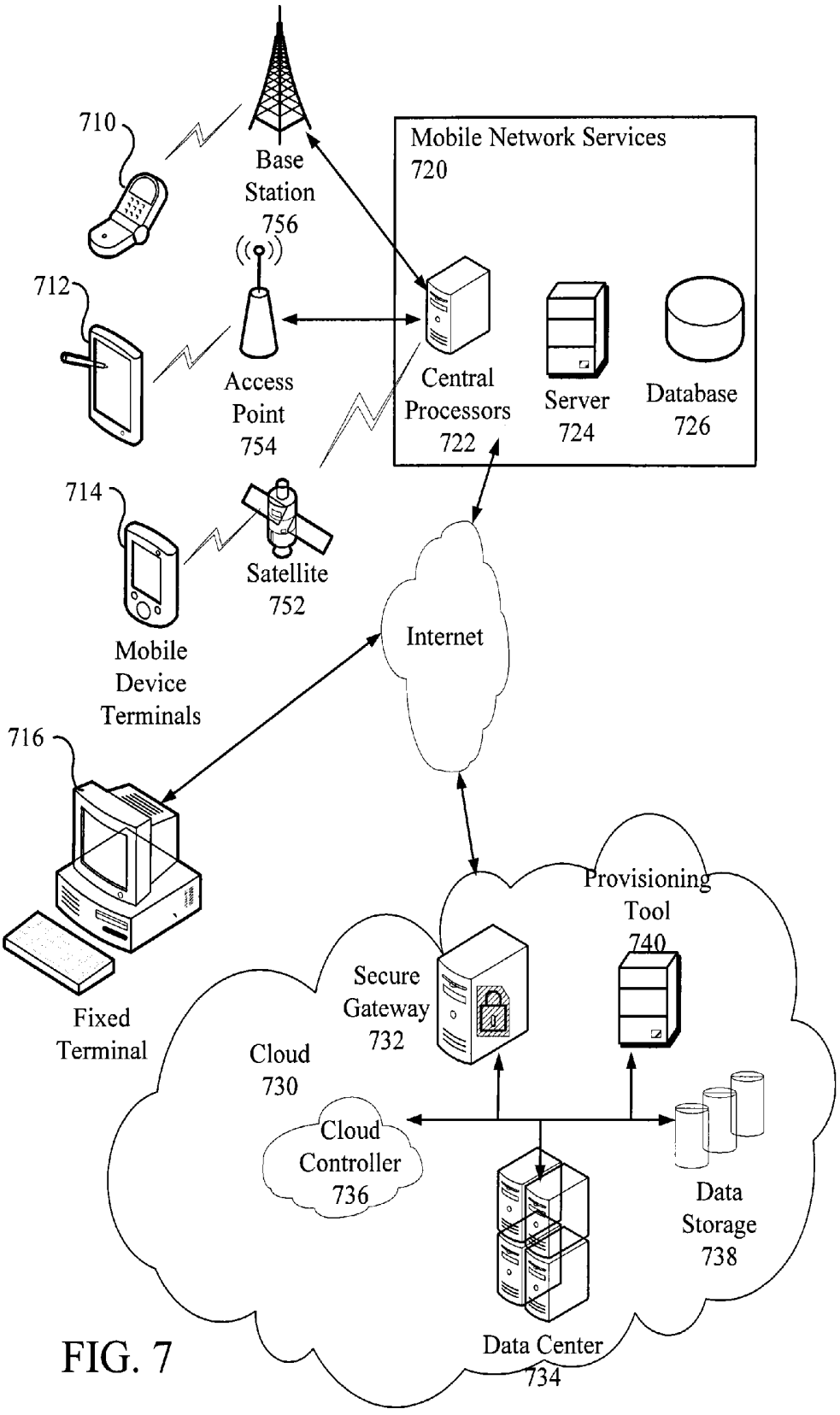

710
Base Station 756
Mobile Network Services 720
712
Access Point 754
Central Processors 722
Server 724
Database 726
714
Satellite 752
Mobile Device Terminals
Internet
716
Fixed Terminal
Provisioning Tool 740
Secure Gateway 732
Cloud 730
Cloud Controller 736
Data Storage 738
Data Center 734

FIG. 7

METHOD AND APPARATUS FOR THE TRICHOTOMOUS IDENTIFICATION OF MORBIDITY, MORTALITY AND SURVIVAL WITHOUT NEW MORBIDITY FROM INTENSIVE CARE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is based upon and claims the benefit of priority from U.S. Application No. 62/040,244, filed Aug. 21, 2014, and U.S. Application No. 62/099,845, filed Jan. 5, 2015, the entire contents of which are incorporated herein by reference.

BACKGROUND

[0002] Mortality adjusted for physiological status and other case mix factors has been a core methodology of adult, pediatric and neonatal intensive care assessments for decades. Users of these methods have been early proponents of standardized mortality ratios for quantitative, unit-based quality assessments for both internal and external benchmarking. Case-mix adjusted survival and death rates are primary outcomes for national databases beyond critical care medicine. For example, the Agency for Healthcare Research and Quality and the Centers for Medicare and Medicaid publish hospital mortality rates for common conditions including acute myocardial infarction, stroke, congestive heart failure, pneumonia, hip fractures, and gastrointestinal hemorrhage.

[0003] Numerous studies of the nature and characteristics of Pediatric Intensive Care Units (PICUs) have been conducted, including many by the inventor of this application. Such studies routinely emphasize that there is dramatic variability among PICUs in their patient populations, characteristics of care, and even organizational characteristics. Importantly, there is also substantial variability in crude and adjusted mortality and morbidity rates among PICUs.

[0004] Mortality rates in pediatric intensive care units have decreased since the original methods adjusting for physiological dysfunction were developed, and medical therapies are increasingly focused on reducing morbidity in survivors. Therapeutic initiatives such as hypothermia, prevention of secondary injury following head trauma, rapid resuscitation of shock, and early thrombolysis therapy are aimed at reducing survivors' morbidity as well as improving survival rates. However, most quantitative outcome assessment methods continue to focus on the dichotomous outcome of survival versus death.

[0005] There is a need to address morbidity following pediatric intensive care, especially morbidity that affects functional status. Moreover, given the decreasing PICU mortality rates, the ability to more finely assess outcomes among surviving children in terms of morbidity allows the opportunity to distinguish between different care practices at a more refined level, thereby furthering the opportunity to improve patient outcomes.

[0006] Critical Care in general and Pediatric Critical Care in particular have developed excellent measures of severity of illness calibrated to mortality. Mortality prediction models are highly dependent on physiologic status that includes cardiovascular, neurological, respiratory, renal, metabolic, and hematological dysfunction. However, severity may be reflected in morbidity as well as in survival. For example, physiologic dysfunctions such as cardiovascular compromise may cause neurological injury and/or be associated with long-term cardiac compromise. Low blood sugar has a risk for neurological injury. Coagulopathies are associated with intracranial hemorrhage. Morbidity is in the progression of injury resulting from physiologic dysfunction such that morbidity is an intermediate outcome and death is the final outcome. Incorporation of morbidity into severity of illness models encourages uses such as assessment of quality of care, clinical uses such as decision-support aids, and future studies including forecasting economic and social impacts of intensive care based on contemporary patient data.

[0007] Recently, a reliable and rapid quantitative assessment of functional status for children analogous to the activities of daily living scale used in adults was developed. This development is especially pertinent to large outcome studies. Previous methods for children were either (a) time consuming to conduct, (b) limited to older infants and children, or simply required too much subjective assessment and future projection by raters (Pediatric Cerebral and Overall Performance Scales). Since the median age of patients in PICUs is less than 3 years in most PICUs, measures that do not include the complete age spectrum are not relevant even to a majority of children. This development of a rapid and reliable method of measuring functional status enables the development and use of methods to assess morbidity risk.

SUMMARY

[0008] New morbidity is associated with physiological status in the cardiovascular, respiratory, neurological and hematological systems in a similar fashion as to that of mortality with physiological status. Morbidity increases as physiological dysfunction increases and then decreases as the physiological dysfunction becomes sufficiently large to change potential morbidities into mortalities.

[0009] New morbidity significantly affecting functional status is often an event along the path toward mortality as both outcomes are strongly associated with the degree of physiological alterations. In pediatric critical care, new morbidity assessed by change in functional status is almost twice as common as mortality and could serve as a new, clinically relevant and important outcome for clinical trials and quality studies to supplement the relatively low rate of mortality.

[0010] The inventors have determined that morbidity, like mortality, is associated with physiological dysfunction and could be predicted simultaneously with mortality. Assessments of care including quality assessments adjusted for physiological status should include the development of new morbidities as well as mortalities.

[0011] The inventors assessed morbidity with the Functional Status Scale (FSS), and defined at an increase of ≥3 from pre-illness to hospital discharge. Physiological status was measured by the Pediatric Risk of Mortality (PRISM) III score.

[0012] The inventors developed a multivariate trichotomous prediction model to assess the potential for simultaneous prediction of morbidity and mortality.

[0013] In accordance with the present disclosure, the Functional Status Scale, a rapid and reliable measure of functional status can be validated against the Adaptive Behavior Assessment System II as an outcome measure suitable for multistate outcome assessments of infants and children.

[0014] In accordance with the present disclosure, trichotomous outcomes of intensive care (death, survival with new morbidity defined by a significant decrease in functional sta-

tus, and survival without a new decrement in functional status) can be predicted from acute physiologic status, acute and chronic diagnoses, chronic health status including functional status, and other information derived from the first hours of pediatric intensive care.

[0015] In accordance with the present disclosure, there is a significant correlation between hospital discharge functional status and 6-month and 12-month post-discharge functional status for children discharged from the Pediatric ICU.

[0016] Accordingly, an objective of the present disclosure is to validate a rapid, and reliable measure of functional status applicable to the full age group of pediatric patients while demonstrating both the feasibility and an excellent likelihood of success.

[0017] The objective of the present disclosure is to validate a predictor of three outcome states from pediatric intensive care: death, survival with new morbidity defined by a significant decrease in functional status, and survival without a new decrement in functional status

[0018] Another objective of the present disclosure is to classify proportions of patients that fall into the appropriate categories. Many of these children will present to the Pediatric ICU with chronic functional disabilities. Therefore, the predictor must be able to account for both those with existing disabilities on admission and those with new disabilities associated with the current ICU illness. Pediatrics in particular, but also adult medicine would be altered by this conceptual change in anticipated prediction relevance of a severity measure.

[0019] Secondary benefits include the provision of a standard physiologic and descriptive database that is designed to provide appropriate baseline data for long-term follow-up studies including long-term functional status and economic issues.

[0020] In accordance with the present disclosure, new morbidities associated with physiological status can be modeled simultaneously with mortality utilizing trichotomous outcome models. New morbidities significantly affecting functional status at hospital discharge can be modeled simultaneously with mortality according to factors including physiological status measured by the PRISM III score, age, admission source, and other diagnostic factors. Trichotomous modeling uncovers the phasic association of morbidity risk with physiological status and produces a well-performing model for simultaneous prediction of both morbidity and mortality suitable for risk adjustment in research, quality and other studies.

[0021] According to some embodiments, a method for determining a patient risk comprises obtaining patient information for a patient admitted to a medical facility, the patient information including patient descriptive information, diagnostic information and physiological information, determining a patient score according to the physiological information, and simultaneously determining, by circuitry, a patient morbidity risk and a patient mortality risk for the patient according the patient descriptive information, the diagnostic information and the patient score.

[0022] The determining of the patient score according to the physiological information may further comprise identifying a numerical value for the patient descriptive information, the diagnostic information and the physiological information, and determining the patient score by computing the numerical values.

[0023] The physiological information may include information about a condition of the patient prior to admission to the medical facility. The physiological information may include information about a condition of the patient upon admission to the medical facility. The patient descriptive information may include patient history information.

[0024] According to some embodiments, the patient is admitted to an intensive care unit of the medical facility when the patient has a congenital or acquired heart defect, the patient is less than three months of age, and the patient score is determined within a period of 2 hours prior to admission and 4 hours after a cardiac interventional procedure. Further, the information consisting of the new morbidity and mortality risks of the patient may be used by the medical staff/parents/family to better understand the patient's prognosis and to aid in medical decision making.

[0025] According to some embodiments, a method for evaluating a quality of care in a hospital comprises collecting patient information of a group of patients treated in the hospital over a period of time, the patient information for each patient of the group of patients including patient descriptive information, diagnostic information, and physiological information, determining, by circuitry, an expected number of patients with new morbidities of the group of patients according to the patient information, determining an actual number of patients with new morbidities of the group of patients according to the patient information, determining, by the circuitry, an expected number of mortalities of the group of patients according to the patient information, determining an actual number of mortalities of the group of patients according to the patient information, and determining, by the circuitry, the quality of care in the hospital according to the expected and actual number of patients with new morbidities and the expected and actual number of mortalities.

[0026] According to some embodiments, the physiological information may include information about a condition of the patient prior to admission to the medical facility. The determining of the expected number of patients with new morbidities comprises determining, for each patient of the group of patients, a patient score according to the physiological information, for each patient, simultaneously determining, by the circuitry, a patient morbidity risk and a patient mortality risk of the patient according the patient descriptive information, the diagnostic information and the patient score, and calculating, by the circuitry, the expected number of patients with new morbidities according to the patient morbidity risk of each patient in the group of patients.

[0027] According to some embodiments, the determining of the patient score according to the physiological information comprises identifying a numerical value for the patient descriptive information, the diagnostic information and the physiological information, and determining the patient score by computing the numerical values. The physiological information may include information about a condition of the patient upon admission to the medical facility. The patient descriptive information may include patient history information.

[0028] An apparatus in accordance with embodiments of the present disclosure comprises circuitry configured to obtain patient information for a patient, the patient information including patient descriptive information, diagnostic information, and physiological information, determine a patient score according to the physiological information, and simultaneously determine a patient morbidity risk and a

patient mortality risk for the patient according the patient descriptive information, the diagnostic information and the patient score.

[0029] To determine the patient score, the circuitry may be configured to identify a numerical value for the patient descriptive information, the diagnostic information and the physiological information, and determine the patient score by computing the numerical values. The circuitry may be configured to collect patient information for a group of patients over a period of time, the group of patients including the patient, determine an expected number of patients with new morbidities of the group of patients according to the descriptive information, the diagnostic information, and the physiological information, determine an actual number of patients with new morbidities of the group of patients according to the patient descriptive information, the diagnostic information and the physiological information, determine an expected number of mortalities of the group of patients according to the descriptive information, the diagnostic information, and the physiological information, determine an actual number of mortalities of the group of patients according to the patient descriptive information, the diagnostic information and the physiological information, and determine the quality of care in the hospital according to the expected and actual number of patients with new morbidities and the expected and actual number of mortalities.

[0030] According to some embodiments, to determine the expected number of patients with new morbidities, the circuitry is further configured to determine, for each patient of the group of patients, a patient score according to the physiological information, simultaneously determine, for each patient, a patient morbidity risk and a patient mortality risk of the patient according the descriptive information, the diagnostic information, and the patient score, and calculate the expected number of patients with new morbidities according to the patient morbidity risk and the patient mortality risk of each patient in the group of patients. When the patient is not admitted to an intensive care unit of the medical facility and the patient is over 3 months of age, the circuitry calculates the patient score within a period of 2 hours prior to admission and 4 hours after admission to the medical facility.

[0031] Although this discussion focuses on modeling morbidity and mortality in pediatric ICUs, the modeling also applies to patients in neonatal and adult intensive care units, i.e. such patients have a similar relationship between morbidity and physiological dysfunction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] A more complete appreciation of the disclosure and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

[0033] FIG. **1** illustrates a flow chart of a method for the determination of a patient simultaneous morbidity and mortality risk.

[0034] FIG. **2** illustrates a flow chart of a method for the assessment of a quality of care of a hospital.

[0035] FIG. **3** illustrates a flow chart of a method for the allocation of resources in a hospital system.

[0036] FIG. **4** illustrates a schematic diagram of an exemplary device in accordance with the present disclosure.

[0037] FIG. **5** illustrates a schematic diagram of a data processing system for performing the methods illustrated in FIGS. **1-3**.

[0038] FIG. **6** illustrates a schematic diagram of CPU **530**.

[0039] FIG. **7** illustrates a schematic diagram of a plurality of devices connected over a network for performing the methods illustrated in FIGS. **1-3**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0040] Conceptually, severity of illness may be considered a continuous variable with extremes of outcomes (survival, death) occurring at low and high values. Although the threshold value that determines the outcome may vary from patient to patient, the concept of severity of illness is useful in the treatment of patients in pediatric, neonatal and adult intensive care, utilizing scoring systems such as PRISM, SNAP, APACHE, and many more.

[0041] The utilization of current methods for determining a severity of illness have successfully adjusted mortality rates for the severity differences of different populations. However, intermediate outcomes associated with physiologic status (e.g. compromised functional status) may occur between the extremes and at different points on a severity of illness scale.

[0042] Physiology-based mortality predictors, such as PRISM, combine a multitude of patient-related variables (e.g. cardiovascular, neurological, metabolic, respiratory, renal, and hematological) in multivariate models to reflect their contribution to mortality risk. Extreme dysfunction of the magnitude that contributes to mortality risk is also associated with potential disability as well as death. For example, neurological injury as well as permanent effects on each individual organ system of a patient may result from these physiologic deviations. Reductions in blood flow evidenced by blood pressure and heart rate changes, poor oxygenation, low blood sugar, poor coagulation, etc., may increase the risk of neurological injury. Acute respiratory, cardiovascular, and renal failures risk long-term organ system dysfunction. Further, physiologic dysfunction is also correlated with length of Pediatric ICU stay, increasing the "opportunities" for morbidities secondary to new insults such as nosocomial infections.

[0043] However, until the present work of the inventors, there has been no research into how an initial severity of illness, assessed by routine ICU methods of physiologic status, is related to hospital discharge, intermediate and long-term functional status. The present disclosure addresses this issue by applying severity of illness methodologies to the identification and prediction of hospital discharge functional status which is correlated to intermediate and long-term functional status of patients treated in ICUs.

[0044] Measuring functional status and outcomes requires an understanding of the type of functioning that is being assessed. Traditional intelligence scales by themselves would miss many children with severe, non-cognitive dysfunction. Adaptive behavior is a conceptually appealing way to make traditionally adult concepts of disability and dependency relevant in infants and children.

[0045] Age-appropriate scales measuring adaptive abilities in daily living, communication, socialization and motor skills are available that span appropriate age groups. The Vineland Adaptive Behavior Scales (VABS), the Adaptive Behavior Scale (ABS) II and the Adaptive Behavior Assessment Sys-

tem (ABAS) II are standard pediatric instruments for classifying individuals into functional categories for outcome evaluation.

[0046] The present discussion utilizes the Functional Status Scale (FSS) for determining age appropriate functional status and new decrements in functional status. The VABS score was used for determining criterion validity and the ABAS II was used for validation of the FSS. Other scales may be utilized for the determination of functional status and outcomes of infants, children and adults, such as Glasgow Outcome Scale (GOS), Functional Independence Measure (FIM and weeFIM), the Level of Cognitive Functioning Scale (Los Ranchos Los Amigos Scale), Rappaport's Disability Rating Scale the Pediatric Overall Performance Category (POCP) scale, and the Pediatric Cerebral Performance Category (PCPC) scale.

[0047] FIG. **1** illustrates a flow chart of a method for the determination of a patient morbidity risk. In an exemplary implementation, method **100** of FIG. **1** is performed by a processor or circuitry of a computer terminal, mobile apparatus, or network device. The processor or circuitry will be described later with respect to FIGS. **4-7**.

[0048] Method **100** begins at step **110**, wherein patient information is obtained. In an exemplary implementation, patient information is collected by a medical professional at a time of patient admission, although the patient information may be collected by other means, such as by a parent, relative, doctor, or other professional. Further the patient information may be collected prior to or after patient admission to a hospital or other medical facility.

[0049] The patient information may include any or all of patient descriptive information, diagnostic information and physiological information.

[0050] Patient descriptive information may include patient history information. Examples of patient descriptive information include general ICU admission data such as: admission date and time; date of birth; elective/emergency status; operative status; clinical service of primary responsibility; previous ICU admissions during the current hospitalization; prior diagnoses; age; catastrophic conditions prior to admission (e.g. respiratory, cardiac arrests); clinical service(s) of primary responsibility; known mental retardation or developmental delay and how determined; the FSS (to be discussed later) prior to ICU admission (from medical record, parents or care provider). Data pertinent to "lead time bias" may include the referring location, and the duration of hospitalization prior to ICU admission (if from the ER, duration of time in the ER).

[0051] Diagnostic information of a patient may include any of the following: principle and underlying diagnoses; worst and best neurological functioning (best motor response, GCS, and level of consciousness); iatrogenic states influencing physiologic variables (e.g. pharmacologically induced paralysis and coma); catastrophic events; operative status; and changes in diagnoses, and physiological system(s) of dysfunction requiring admission to the hospital or intensive care unit.

[0052] Physiologic information may include measurements such as systolic and diastolic blood pressure, heart rate, mental status, pupillary reflexes, temperature, pH, total CO_2, PCO_2, PaO_2, glucose, potassium, BUN, creatinine, WBC count, platelet count, and prothrombin and partial thromboplastin times (PT/PTT).

[0053] Upon collection, the patient information may be entered into a medical database. After the patient information is obtained, the method proceeds to step **120**.

[0054] In step **120**, numerical values are assigned to the physiological information. Numerical values may also be assigned to the patient descriptive information and the diagnostic information.

[0055] After numerical values are assigned to the patient information, a patient score is determined in step **130**.

[0056] In step **130**, the patient score is determined. In an exemplary implementation, the patient score is calculated from the numerical values of the physiological information. The patient score may also be calculated from other data items, such as the numerical values of the patient descriptive information and the diagnostic information.

[0057] The patient score may be determined by calculating a PRISM III score. For example, the PRISM III score is calculated according to the following (1)-(5).

[0058] (1) If the patient is NOT admitted to the intensive care unit for cardiac surgery or an interventional cardiac catheterization, or is over 3 months of age, use period from 2 hours prior to admission to 4 hours after admission to assess laboratory variables and the time period from admission to 4 hours after admission to assess physiological variables.

[0059] (2) If the patient is admitted to the intensive care unit for cardiac surgery or an interventional cardiac catheterization and is under 3 months of age, use the following table to determine the time interval to assess the PRISM III score:

TABLE 1

Age at Admission	ICU length of stay prior to Cardiac Intervention	PRISM III Collection Time Interval
<24 hours	≤12 hours	Admission
	12 hours-10 days	Post-Intervention
24 hours to 10 days	0-10 days	Post-Intervention
	>10 days	Admission
11 days to 30 days	≤48 hours	Post-Intervention
	>48 hours	Admission
31 days to 90 days	≤48 hours	Post-Intervention if cardiac surgery Admission if cardiac catheterization
	>48 hours	Admission
>90 days	All	Admission

[0060] The admission time interval refers the period of the 2 hours prior to admission to 4 hours after admission for laboratory data and the first 4 hours of PICU care for other physiological variables. The post-intervention time interval refers to the first 4 hours of PICU care after a cardiac intervention (surgery or interventional catheterization, but not diagnostic catheterization).

[0061] (3). The Pediatric Risk of Admission (PRISM) III Score is composed of the following Table 2:

Cardiovascular and Neurologic Vital Signs		
Systolic blood pressure (mm Hg)	Score = 3	Score = 7
Neonate	40-55	<40
Infant	45-65	<45
Child	55-75	<55

-continued

Adolescent	65-85	<65
Temperature	Score = 3	
	<33° C. or >40° C.	
Mental	Score = 5	
Status	Stupor/coma or GCS < 8	
Heart rate (beats per minute)	Score = 3	Score = 4
Neonate	215-225	>225
Infant	215-225	>225
Child	185-205	>205
Adolescent	145-155	>155
Pupillary reflexes	Score = 7	Score = 11
	One fixed	Both fixed
	Acid-Base, Blood Gases	
Acidosis (pH or total CO2)	Score = 2	Score = 6
pH	7.0-7.28	<7.0
CO2	5-16.9	<5
PCO2	Score = 1	Score = 3
(mm Hg)	50-75	>75
Alkalosis: Total CO2 (mmol/L)	Score = 4	
	>34	
PaO2	Score = 3	Score = 6
(mm Hg)	42-49	<42
	Chemistry Tests	
Glucose	Score = 2	
	>200 mg/dL or >11 mmol/L	
Potassium (mmol/L)	Score = 3	
	>6.9	
Blood urea nitrogen (BUN)	Score = 3	
Neonate	>11.9 mg/dL or >4.3 mmol/L	
All other ages	>14.9 mg/dL or >4.3 mmol/L	
Creatinine	Score = 2	
Neonate	>0.85 mg/dL or >75 mmol/L	
Infant	>0.90 mg/dL or >80 mmol/L	
Child	>0.90 mg/dL or >80 mmol/L	
Adolescent	>1.30 mg/dL or >115 mmol/L	
	Hematology Tests	
White blood cell count (cells/mm3)	Score = 4	
	<3,000	
Platelet Count (×103 cells/mm3)	Score = 2	Score = 4 Score = 5
	100-200	50-99 <50
Prothrombin time (PR) or Partial thrombo-plastin (time) (PTT)	Score = 3	
Neonate	PT > 22 or PTT > 85	
All other ages	PT > 22 or PTT > 57	

GCS = Glasgow Coma Scale.

[0062] (4) A neonate is <30 days of age, an infant is 30 days to <12 months of age, a child is 12 months of age to <=144 months of age, and an adolescent is >144 months of age.

[0063] (5) The neurological PRISM III is composed of the mental status and pupillary reflex scores and the non-neurological PRISM III is composed of all other PRISM III components.

[0064] After calculation of the patient score, the method proceeds to step **140**.

[0065] In step **140**, a morbidity risk and a mortality risk are simultaneously determined. In particular, the morbidity risk and the mortality risk are simultaneously determined according to the patient descriptive information, the diagnostic information and the patient score calculated in step **130**.

[0066] In an exemplary implementation, morbidity risk increases with increasing PRISM III scores and then decreases as potential morbidities increasingly become mortalities. In the trichotomous relationship assessed in the present disclosure, the relationship of PRISM III with mortality changes very little after accounting for simultaneous morbidity risk. However, the relationship of morbidity with PRISM III changes substantially after accounting for mortality risk; morbidity risk initially increases with higher PRISM III scores, but then decreases with further increases in the PRISM III scores whose mortality risk is high.

[0067] The following equation is used for the simultaneously determine a morbidity risk and a mortality risk, as in step **140**:

$$P = \frac{1}{1 + e^{-(\beta_0 + x \cdot \beta)}}$$

[0068] where β_0 is the intercept, β is the coefficient for each of the independent variables, and x is the coefficient. The computation of morbidity risk and mortality risk separately utilizes the morbidity intercept β_0 and the sum of for each independent variable β multiplied by its respective coefficient (x). The value of the categorical variable is assigned 1 if it is present or 0 if the categorical variable is absent. The values of the PRISM III Neurological Score and the PRISM III non-Neurological Score are recorded as the PRISM III score determined by Table 2. Table 3 includes values that demonstrate the statistical precision and reliability of the trichotomous model according to the present disclosure.

TABLE 3

Trichotomous Outcome Model for Simultaneous Prediction of Morbidity and Mortality.

Predictors	Morbidity Coefficients (SE)	Odds Ratios: New Morbidity vs. No New Morbidity (95% CI)	Mortality Coefficients (SE)	Odds Ratios: Death vs. No New Morbidity (95% CI)
Intercept	−3.92 (0.17)	NA	−5.51 (0.27)	NA
Age at PICU Admission				
0 day to <14 days	0.80 (0.23)	2.23 (1.43, 3.49)	1.64 (0.27)	5.14 (3.00, 8.79)
14 days to <1 month	0.47 (0.44)	1.61 (0.68, 3.79)	1.26 (0.56)	3.53 (1.19, 10.50)

TABLE 3-continued

Trichotomous Outcome Model for Simultaneous Prediction of Morbidity and Mortality.

Predictors	Morbidity Coefficients (SE)	Odds Ratios: New Morbidity vs. No New Morbidity (95% CI)	Mortality Coefficients (SE)	Odds Ratios: Death vs. No New Morbidity (95% CI)
1 month to <12 months	0.39 (0.14)	1.48 (1.13, 1.93)	0.42 (0.21)	1.52 (1.02, 2.28)
>12 months	Reference	Reference	Reference	Reference
Admission Source				
Direct admission: Referral Hospital	0.76 (0.15)	2.15 (1.59, 2.90)	1.09 (0.24)	2.96 (1.87, 4.70)
Inpatient Unit: Same Hospital	0.87 (0.18)	2.38 (1.67, 3.39)	1.70 (0.25)	5.46 (3.33, 8.95)
Emergency Department: Same Hospital	0.11 (0.16)	1.12 (0.81, 1.53)	0.64 (0.25)	1.90 (1.16, 3.14)
OR/PACU for Postoperative Care	Reference	Reference	Reference	Reference
Cardiac Arrest (1)	0.97 (0.33)	2.63 (1.38, 5.00)	1.52 (0.33)	4.56 (2.40, 8.66)
Acute (non-Primary) or Chronic Diagnosis of Cancer (1)	0.25 (0.28)	1.28 (0.74, 2.21)	0.89 (0.30)	2.44 (1.36, 4.40)
Trauma (1)	1.18 (0.19)	3.26 (2.23, 4.77)	0.81 (0.35)	2.26 (1.13, 4.51)
Primary System of Dysfunction				
Cardiovascular/Respiratory	Reference	Reference	Reference	Reference
Cancer	0.73 (0.28)	2.07 (1.20, 3.59)	0.90 (0.43)	2.47 (1.06, 5.74)
Low Risk (DKA, Hematologic, Musculoskeletal, Renal)	−0.93 (0.31)	0.39 (0.21, 0.72)	−1.69 (0.61)	0.18 (0.06, 0.61)
Neurologic	0.38 (0.15)	1.46 (1.08, 1.98)	−0.07 (0.25)	0.93 (0.57, 1.54)
Other	−0.21 (0.23)	0.81 (0.52, 1.28)	0.11 (0.31)	1.11 (0.61, 2.03)
Baseline FSS Score Categorized as Good (1, 2)	−0.23 (0.13)	0.80 (0.61, 1.03)	−0.66 (0.19)	0.52 (0.36, 0.74)
PRISM III Neurological Score (3, 4)	0.11 (0.02)	1.12 (1.08, 1.16)	0.21 (0.02)	1.24 (1.19, 1.29)
PRISM in Non-Neurological Score (4)	0.09 (0.01)	1.09 (1.07, 1.12)	0.18 (0.01)	1.19 (1.16, 1.23)

NA = not applicable

(1). Reference is absence of the factor.

(2). Baseline FSS score = 6 or 7.

(3). PRISM III neurological components are pupillary reactions and mental status.

(4). For each one point change.

[0069] After the morbidity risk and the mortality risk are determined in step **140**, the morbidity risk and mortality risk may be utilized in many ways. For example, the morbidity risk and mortality risk may be utilized for the allocation of hospital resources, such as the allocation of hospital beds in a pediatric intensive care unit. Description of the allocation of beds according to a calculated length of stay of a patient is described in U.S. Pat. No. 5,809,477, issued Sep. 15, 1998, the entirety of which is incorporated by reference.

[0070] The morbidity risk and mortality risk may be utilized may be also utilized for the determination of a quality of care of a medical facility, as discussed with reference to FIG. **2**.

[0071] FIG. **2** illustrates a flow chart of a method for the assessment of a quality of care of a hospital. In an exemplary implementation, method **200** of FIG. **2** is performed by a processor or circuitry of a computer terminal, mobile apparatus, or network device. The processor or circuitry will be described later with respect to FIGS. **4-7**.

[0072] Method **200** begins in step **210**, where patient information for a group of patients is collected. For example, step **210** may correspond to step **110** of FIG. **1**. In some embodiments, a user may determine an evaluation period for the assessment of the quality of care. The evaluation period may be determined before, concurrently or after step **210**. Further, the user may determine a particular group patients in the hospital for which the quality of care may be assessed. For example, only a specific subset of patients from the hospital, such as patients treated within a specific department or by a single doctor, may be selected. Or, the user may determine a single patient for whom the knowledge or morbidity and/or mortality risk may be useful information to the healthcare workers, the patient, and/or the family.

[0073] In step **220**, an expected number of new morbidities and mortalities in the group of patients is calculated. The calculation of the expected number of new morbidities and mortalities may utilize the simultaneous determination of morbidity and mortality risk as in step **140** of FIG. **1**.

[0074] In an exemplary implementation, the calculation in step **220** may include the calculation of an expected morbidity rate and an expected mortality rate. From such calculated rates, the expected new morbidities and mortalities may be determined.

[0075] The expected morbidity rate of the group of patients may be calculated according to the morbidity risk assessed for each patient of the group of patients. For example, the expected morbidity rate of the group of patients may be calculated according to a summation of the individual patient risks, average, weighted average, median or other statistical calculation of the morbidity risk assessed for each patient of the group of patients.

[0076] In step **230**, the actual number of new morbidities and mortalities in the group of patients is calculated. In an exemplary implementation, the actual number of new mor-

bidities and mortalities may be determined and the rates calculated using the size of the group. Alternatively, the number of new morbidities and mortalities may be calculated by calculating an actual morbidity rate and an actual mortality rate for the group of patients. From such actual morbidity and mortality rates, the actual number of new morbidities and mortalities may be determined according to a size of the group of patients.

[0077] The actual morbidity rate may represent a value equal to a number of patients discharged with impaired functional status divided by a total number of patients discharged by the hospital. The actual morbidity rate of the group of patients may be calculated a predetermined period of time after the entire group of patients has completed treatment or been discharged from the hospital. The actual morbidity rate may be calculated according to a count, percentage, fraction, average, weighted average, median or other statistical calculation of the group of patients. In an exemplary implementation, the actual morbidity rate may be calculated in step **230** according to a same method as the calculation of the expected morbidities as in step **220**.

[0078] The analysis of actual morbidity status may also include analysis of the relationship of functional status on hospital discharge to initial hospital functional status and occurrences that may influence it. Potential influences on functional status include such items as diagnosis, surgery, physiological instability (PRISM III score), steroid use, sedation, paralysis, length of stay, known complications, etc.

[0079] In step **240**, the expected number of new morbidities and mortalities and the actual number of new morbidities and mortalities are compared. From such a comparison, the method proceeds to step **250**.

[0080] In step **250**, a quality of care of a hospital is assessed. In an exemplary implementation, a quality of care of the hospital may be determined according to the comparison performed in step **240**. Further, the quality of care of the hospital may be determined according to a first ratio between the actual number of new morbidities and mortalities, as calculated in step **230**, and the expected number of new morbidities and mortalities, as calculated in step **220**.

[0081] The actual number of new morbidities divided by the expected number of new morbidities is termed the Standardized Morbidity Ratio. The actual number of mortalities divided by the expected number of mortalities is termed the Standardized Mortality Ratio Ratios significantly greater than 1 indicate less than expected quality of care and ratios significantly less than one indicate better than expected quality of care. The Standardized Morbidity Ratio and the Standardized Mortality Ratio may undergo statistical analysis, most commonly with parametric tests such as the z-score.

[0082] Thus, one application of the present disclosure is to improve care. In particular, as a result of the system determining quality of care of a pediatric ICU by way of mortality and morbidity scores for a predetermined time period and comparing these mortality and morbidity scores against a predetermined threshold, it is possible to identify an underperforming pediatric ICU. Once the underperforming ICU is identified, steps can be taken to address these issues. The assessment of under-performance is individualized but may consist of specific care giver performance, policies and procedures, care practices, levels of training, education issues, etc. The system can also be used to identify the same factors that correspond to lower mortality and morbidity scores.

[0083] FIG. **3** illustrates another method for the utilization of the morbidity and mortality risks as determined in step **140** of FIG. **1**.

[0084] In particular, FIG. **3** illustrates a flow chart of a method for the allocation of resources in a hospital system. In an exemplary implementation, method **300** of FIG. **3** is performed by a processor or circuitry of a computer terminal, mobile apparatus, or network device. The processor or circuitry will be described later with respect to FIGS. **4-7**.

[0085] In step **310**, a morbidity risk of a patient is determined. The determination of the morbidity risk of the patient may be performed as in method **100** of FIG. **1**.

[0086] In step **320**, available resources of a plurality of hospitals are determined. For example, in a hospital network that includes three hospitals, the available resources of the three hospitals is determined. In another embodiment, the available resources of a plurality of units or departments within a hospital or a plurality of hospitals are determined. For example, in a hospital network that includes two hospitals, and the hospitals include a total of nine units/departments, the available resources of the two hospitals and the nine units/departments are determined.

[0087] In step **330**, a particular hospital of the plurality of hospitals is chosen for a newly-admitted patient according to the available resources of the plurality of hospitals. The particular hospital may be chosen according to the patient's morbidity risk, the patient's preferences and/or preferences of the patient's family. Further, a particular unit/department of a hospital may be chosen according to factors such as the patient's morbidity risk, the patient's preferences and/or preferences of the patient's family.

[0088] In step **340**, it is determined whether the chosen hospital is the hospital at which the patient has been newly-admitted. If it is determined that the chosen hospital is the hospital at which the patient has been newly-admitted, the method proceeds to step **360**. If, however, it is determined that the chosen hospital is a different hospital than the one at which the patient has been newly-admitted, the method proceeds to step **350**.

[0089] In step **350**, the newly-admitted patient is relocated to the chosen hospital. After relocation of the patient to the chosen hospital, the method proceeds to step **360**.

[0090] In step **360**, the newly-admitted patient is assigned the hospital resource at the chosen hospital. For example, should the available resource at issue be a bed, the newly-admitted patient is assigned a bed.

[0091] In an exemplary implementation, the available hospital resources may be a number of available beds for patients. However, the available hospital resources could be medical equipment (e.g. scanning equipment, life-assist devices such as ventilators and/or blood filters), medical personnel and/or medical supplies.

[0092] For example, an available number of hospital beds may be determined according to a difference between a total number of hospital beds and an occupied number of hospital beds. In an exemplary implementation, the available hospital resources are determined according to a request time and date. In such an implementation, the occupied number of hospital beds may be equal to a sum of the number of patients in which the LOS overlaps with the requested time and date.

[0093] In another example, an available number of beds in an ICU at a future requested time and date may be determined according to a difference between a total number of hospital beds in the ICU and an expected number of hospital beds to be

occupied in the ICU. The expected number of hospital beds to be occupied in the ICU may be equal to a sum of the number of patients in which the LOS overlaps with the requested time and date.

[0094] Moreover, in some embodiments, it is determined in step **340** whether or not the particular unit/department at which the patent is newly-admitted is the chosen unit/department. Should the chosen hospital be another unit/department within a same hospital, the patient may be relocated to the other unit/department in step **350** to be then assigned the hospital resource in step **360**.

[0095] FIG. **4** illustrates device **400** in accordance with the present disclosure. In an exemplary embodiment as illustrated in FIG. **4**, device **400** includes a CPU **428** which may perform the methods described above with respect to FIGS. **1-3**. Process data and instructions for the calculations and other method steps as described above with respect to FIGS. **1-3** may be stored in memory **402**. These processes and instructions may also be stored on a storage medium disk **404** such as a hard drive (HDD) or portable storage medium or may be stored remotely. Moreover, the instructions may be stored on CDs, DVDs, in FLASH memory, RAM, ROM, PROM, EPROM, EEPROM, hard disk or any other information processing device with which device **400** communicates, such as a server (remote or local) or computer.

[0096] Further, the process data and instructions may be provided as a utility application, background daemon, or component of an operating system, or combination thereof, executing in conjunction with CPU **428** and an operating system such as Microsoft Windows 7, UNIX, Solaris, LINUX, Apple MAC-OS and other systems known to those skilled in the art.

[0097] The hardware elements in order to achieve device **400** may be realized by various circuits or circuitry elements. For example, CPU **428** may be a Xenon or Core processor from Intel of America or an Opteron processor from AMD of America, or may include other types of processors or circuits recognized by one of ordinary skill in the art. Alternatively, the CPU **428** may be implemented on an FPGA, ASIC, PLD or using discrete logic circuits, as one of ordinary skill in the art would recognize. Further, CPU **428** may be implemented as multiple processors cooperatively working in parallel to perform the instructions of the inventive processes described above.

[0098] Device **400** in FIG. **4** may include a network controller **406** for interfacing with network **41**. As can be appreciated, the network **41** can be a public network, such as the Internet, or a private network such as an LAN or WAN network, or any combination thereof and can also include PSTN or ISDN sub-networks. The network **41** can also be wired, such as an Ethernet network, or can be wireless such as a cellular network including EDGE, 3G and 4G wireless cellular systems. Network **41** can also be encompassed via WiFi, Bluetooth, or any other wireless form of communication.

[0099] Device **400** may further include a display controller **408** for interfacing with display **410**, such as an LCD monitor. A general purpose I/O interface **412** interfaces with a keyboard and/or mouse **414** as well as a touch screen panel **416** on or separate from display **410**. General purpose I/O interface also connects to a variety of peripherals **418** including printers and scanners. A sound controller **420** may be provided in device **400**, to interface with speakers/microphone **422** to provide sound output or alerts.

[0100] The general purpose storage controller **424** connects the storage medium disk **404** with communication bus **426**, which may be an ISA, EISA, VESA, PCI, or similar, for interconnecting all of the components of the device **400**. A description of the general features and functionality of the display **410**, keyboard and/or mouse **414**, as well as the display controller **408**, storage controller **424**, network controller **406**, sound controller **420**, and general purpose I/O interface **462** is omitted herein for brevity as these features are known.

[0101] The exemplary circuit elements described in the context of the present disclosure may be replaced with other elements and structured differently than the examples provided herein. Moreover, circuitry configured to perform features described herein may be implemented in multiple circuit units (e.g., chips), or the features may be combined in circuitry on a single chipset, as shown in FIG. **5**.

[0102] FIG. **5** illustrates a schematic diagram of a data processing system, according to certain embodiments, for performing the methods described above with respect to FIGS. **1-3**. The data processing system is an example of a computer in which code or instructions implementing the processes of the illustrative embodiments may be located.

[0103] In FIG. **5**, data processing system **500** employs a hub architecture including a north bridge and memory controller hub (NB/MCH) **525** and a south bridge and input/output (I/O) controller hub (SB/ICH) **520**. The central processing unit (CPU) **530** is connected to NB/MCH **525**. The NB/MCH **525** also connects to the memory **545** via a memory bus, and connects to the graphics processor **550** via an accelerated graphics port (AGP). The NB/MCH **525** also connects to the SB/ICH **520** via an internal bus (e.g., a unified media interface or a direct media interface). The CPU Processing unit **530** may contain one or more processors and even may be implemented using one or more heterogeneous processor systems.

[0104] For example, FIG. **6** shows one implementation of CPU **530**. In one implementation, the instruction register **638** retrieves instructions from the fast memory **640**. At least part of these instructions are fetched from the instruction register **638** by the control logic **636** and interpreted according to the instruction set architecture of the CPU **530**. Part of the instructions can also be directed to the register **532**. In one implementation the instructions are decoded according to a hardwired method, and in another implementation the instructions are decoded according to a microprogram that translates instructions into sets of CPU configuration signals that are applied sequentially over multiple clock pulses. After fetching and decoding the instructions, the instructions are executed using the arithmetic logic unit (ALU) **634** that loads values from the register **632** and performs logical and mathematical operations on the loaded values according to the instructions. The results from these operations can be feedback into the register and/or stored in the fast memory **640**. According to certain implementations, the instruction set architecture of the CPU **530** can use a reduced instruction set architecture, a complex instruction set architecture, a vector processor architecture, a very large instruction word architecture. Furthermore, the CPU **530** can be based on the Von Neuman model or the Harvard model. The CPU **530** can be a digital signal processor, an FPGA, an ASIC, a PLA, a PLD, or a CPLD. Further, the CPU **530** can be an x86 processor by Intel or by AMD; an ARM processor, a Power architecture processor by, e.g., IBM or any other CPU architecture.

[0105] Referring again to FIG. **5**, the data processing system **500** can include that the SB/ICH **520** is coupled through a system bus to an I/O Bus, a read only memory (ROM) **556**, universal serial bus (USB) port **564**, a flash binary input/output system (BIOS) **568**, and a graphics controller **558**. PCI/PCIe devices can also be coupled to SB/ICH **520** through a PCI bus **562**.

[0106] The PCI devices may include, for example, Ethernet adapters, add-in cards, and PC cards for notebook computers. The Hard disk drive **560** and CD-ROM **566** can use, for example, an integrated drive electronics (IDE) or serial advanced technology attachment (SATA) interface. In one implementation the I/O bus can include a super I/O (SIO) device.

[0107] Further, the hard disk drive (HDD) **560** and optical drive **566** can also be coupled to the SB/ICH **520** through a system bus. In one implementation, a keyboard **570**, a mouse **572**, a parallel port **578**, and a serial port **576** can be connected to the system bust through the I/O bus. Other peripherals and devices that can be connected to the SB/ICH **520** using a mass storage controller such as SATA or PATA, an Ethernet port, an ISA bus, a LPC bridge, SMBus, a DMA controller, and an Audio Codec.

[0108] Moreover, the present disclosure is not limited to the specific circuit elements described herein, nor is the present disclosure limited to the specific sizing and classification of these elements. For example, the skilled artisan will appreciate that the circuitry described herein may be adapted based on changes to circuit configuration, power source sizing and/location and network connection.

[0109] The functions and features described herein may also be executed by various distributed components of a system. For example, one or more processors may execute these system functions, wherein the processors are distributed across multiple components communicating in a network. The distributed components may include one or more client and server machines, which may share processing, as shown on FIG. **7**, in addition to various human interface and communication devices (e.g., display monitors, smart phones, tablets, personal digital assistants (PDAs)). The network may be a private network, such as a LAN or WAN, or may be a public network, such as the Internet. Input to the system may be received via direct user input and received remotely either in real-time or as a batch process. Additionally, some implementations may be performed on modules or hardware not identical to those described.

[0110] For example, a user, such as medical personnel, may utilize a fixed terminal **716**, mobile device **714**, PDA **712** and/or phone **710** so as to perform the methods previously described with respect to FIGS. **1-3**. Patient information may be stored locally within the memory of a device, or the patient information may be stored remotely over the internet, via a wireline or wireless network connection (via any of satellite **752**, access point **754**, base station **756**, mobile network services **720**), at locations such as sever **724** or database **726** of mobile network services **720**, data center **734** or data storage **738** of cloud **730**.

[0111] Processing for the calculation, determination and assessments of the methods described with respect to FIGS. **1-3** may be performed locally by circuitry within a respective device, or may be performed remotely and accessed by a central process **722** or data center **734**. Results of processing performed remotely may be transmitted via the internet back to a local device for any output or allocation of hospital resources.

[0112] The above-described hardware description is a non-limiting example of corresponding structure for performing the functionality described herein.

[0113] Discussion will now turn to experimental results and data analysis performed by the inventors that is significant to the present disclosure.

[0114] Preliminary Study

[0115] The Functional Status Scale (FSS) was developed by the Collaborative Pediatric Critical Care Research Network funded by the Eunice Kennedy Shriver National Institute of Child Health and Human Development, National Institutes of Health, Department of Health and Human Services: It was based on the Functional Disability Scale (FDS) was initially developed by Dr. Pollack and two developmental psychologists including Dr. Penny Glass. The FSS is utilized for the rapid and reliable assessment of functional status. There are 6 domains including mental status, communication, sensory, motor functioning, feeding, and respiratory status. Each is graded from 1 (normal) to 5 (very severe dysfunction).

TABLE 4

The Functional Status Scale Score

	1 NORMAL	2 MILD DYSFUNCTION	3 MODERATE DYSFUNCTION	4 SEVERE DYSFUNCTION	5 VERY SEVERE DYSFUNCTION
MENTAL STATUS	Normal sleep/wake; appropriate responsivity	Sleepy but arousable to noise/touch/movement and/or periods of social nonresponsivity	Lethargic and/or irritable	Minimal arousal to stimulus (stupor)	Unresponsive and/or Coma and/or Vegetative
SENSORY	Intact hearing and vision and responsive to touch	Suspected hearing or Suspected vision loss.	Not reactive to auditory stimuli or Not reactive to visional stimuli	Not reactive to auditory stimuli and Not reactive to visional stimuli	Abnormal response to pain or touch
COMMUNICATION	Appropriate non-crying vocalizations, interactive facial expressiveness, or gestures	Diminished Vocalization Diminished Facial Expression and/or social responsiveness	Absence of attention getting behavior	No demonstration of discomfort	Absence of communication
MOTOR FUNCTION	Coordinated body movements and normal muscle control and awareness of action and why it's being done	1 limb functionally impaired	2 or more limbs functionally impaired	Poor head control	Diffuse Spasticity, Paralysis, Decerebrate/Decorticate Posturing

TABLE 4-continued

The Functional Status Scale Score					
	1 NORMAL	2 MILD DYSFUNCTION	3 MODERATE DYSFUNCTION	4 SEVERE DYSFUNCTION	5 VERY SEVERE DYSFUNCTION
FEEDING	All food taken by mouth with age appropriate help	NPO or need for age-inappropriate help with feeding	Oral and tube feedings	Parenteral Nutrition with oral or tube feedings	All parenteral nutrition
RESPIRATORY	Room air and no artificial support or aids	Oxygen and/or Suctioning	Tracheostomy	CPAP for all or part of the day and/or Mechanical ventilator support for part of the day	Mechanical ventilatory support for all of the day and night

[0116] The FSS was validated on a total of 836 children. Each FSS domain was associated with mean ABAS II ($p<0.0001$). Discrimination was very good for moderate and severe dysfunction categories (area under the ROC curve >0.8). Intra-class correlations of original FSS was 0.95. Inter-rater reliability was very good to excellent for the FSS domains.

	Weighted Kappa
Mental Status	0.54
Sensory	0.76
Communication	0.81
Motor Functioning	0.78
Feeding	0.87
Respiratory	0.88

[0117] Studies prior the current studies demonstrated the feasibility of polychotomous outcome prediction in PICU patients.

[0118] The inventor of this application has published the following publication, which is hereby incorporated by reference in its entirety: "Simultaneous Prediction of New Morbidity, Mortality, and Survival Without New Morbidity From Pediatric Intensive Care: A New Paradigm for Outcomes Assessment." Critical Care Medicine; August 2015; Volume 43; Issue 8; pages 1699-1709.

[0119] Obviously, numerous modifications and variations of the present disclosure are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the disclosure may be practiced otherwise than as specifically described herein.

1. A method for determining a patient risk, the method comprising:

obtaining patient information for a patient admitted to a medical facility, the patient information including patient descriptive information, diagnostic information and physiological information;

determining a patient score according to the physiological information; and

simultaneously determining, by circuitry, a patient morbidity risk and a patient mortality risk for the patient according the patient descriptive information, the diagnostic information and the patient score.

2. The method according to claim **1**, wherein the determining of the patient score according to the physiological information further comprises:

identifying a numerical value for the patient descriptive information, the diagnostic information and the physiological information; and

determining the patient score by computing the numerical values.

3. The method according to claim **1**, wherein the physiological information includes information about a condition of the patient prior to admission to the medical facility.

4. The method according to claim **1**, wherein the physiological information includes information about a condition of the patient upon admission to the medical facility.

5. The method according to claim **1**, wherein the patient descriptive information includes patient history information.

6. The method according to claim **1**, wherein the patient is admitted to an intensive care unit of the medical facility when the patient has a congenital or acquired heart defect, the patient is less than three months of age, and the patient score is determined within a period of 2 hours prior to admission and 4 hours after a cardiac interventional procedure.

7. The method according to claim **1**, where the information consisting of the new morbidity and mortality risks of the patient is used by the medical staff/parents/family to better understand the patient's prognosis and to aid in medical decision making.

8. A method for evaluating a quality of care in a hospital, the method comprising:

collecting patient information of a group of patients treated in the hospital over a period of time, the patient information for each patient of the group of patients including patient descriptive information, diagnostic information, and physiological information;

determining, by circuitry, an expected number of patients with new morbidities of the group of patients according to the patient information;

determining an actual number of patients with new morbidities of the group of patients according to the patient information;

determining, by the circuitry, an expected number of mortalities of the group of patients according to the patient information;

determining an actual number of mortalities of the group of patients according to the patient information; and

determining, by the circuitry, the quality of care in the hospital according to the expected and actual number of patients with new morbidities and the expected and actual number of mortalities.

9. The method according to claim **8**, wherein the physiological information includes information about a condition of the patient prior to admission to the medical facility.

10. The method according to claim **8**, wherein the determining of the expected number of patients with new morbidities comprises:

determining, for each patient of the group of patients, a patient score according to the physiological information;

for each patient, simultaneously determining, by the circuitry, a patient morbidity risk and a patient mortality risk of the patient according the patient descriptive information, the diagnostic information and the patient score; and

calculating, by the circuitry, the expected number of patients with new morbidities according to the patient morbidity risk of each patient in the group of patients.

11. The method according to claim **8**, wherein the determining of the patient score according to the physiological information comprises:

identifying a numerical value for the patient descriptive information, the diagnostic information and the physiological information; and

determining the patient score by computing the numerical values.

12. The method according to claim **8**, wherein the physiological information includes information about a condition of the patient upon admission to the medical facility.

13. The method according to claim **8**, wherein the patient descriptive information includes patient history information.

14. A non-transitory computer readable medium storing computer executable instructions that, when executed by a computer, cause the computer to execute the method according to claim **1**.

15. An apparatus, comprising:

circuitry configured to

obtain patient information for a patient, the patient information including patient descriptive information, diagnostic information, and physiological information;

determine a patient score according to the physiological information; and

simultaneously determine a patient morbidity risk and a patient mortality risk for the patient according the patient descriptive information, the diagnostic information and the patient score.

16. The apparatus according to claim **15**, wherein to determine the patient score, the circuitry is further configured to

identify a numerical value for the patient descriptive information, the diagnostic information and the physiological information; and

determine the patient score by computing the numerical values.

17. The apparatus according to claim **15**, wherein the physiological information includes information about a condition of the patient prior to admission to the medical facility.

18. The apparatus according to claim **15**, wherein the circuitry is further configured to

collect patient information for a group of patients over a period of time, the group of patients including the patient;

determine an expected number of patients with new morbidities of the group of patients according to the descriptive information, the diagnostic information, and the physiological information;

determine an actual number of patients with new morbidities of the group of patients according to the patient descriptive information, the diagnostic information and the physiological information;

determine an expected number of mortalities of the group of patients according to the descriptive information, the diagnostic information, and the physiological information;

determine an actual number of mortalities of the group of patients according to the patient descriptive information, the diagnostic information and the physiological information; and

determine the quality of care in the hospital according to the expected and actual number of patients with new morbidities and the expected and actual number of mortalities.

19. The apparatus according to claim **18**, wherein to determine the expected number of patients with new morbidities, the circuitry is further configured to

determine, for each patient of the group of patients, a patient score according to the physiological information;

simultaneously determine, for each patient, a patient morbidity risk and a patient mortality risk of the patient according the descriptive information, the diagnostic information, and the patient score; and

calculate the expected number of patients with new morbidities according to the patient morbidity risk and the patient mortality risk of each patient in the group of patients.

20. The apparatus according to claim **15**, wherein when the patient is not admitted to an intensive care unit of the medical facility and the patient is over 3 months of age, the circuitry calculates the patient score within a period of 2 hours prior to admission and 4 hours after admission to the medical facility.

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专利名称(译)	用于三分法鉴定发病率，死亡率和存活率而没有来自重症监护的新发病率的方法和装置		
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摘要(译)

根据本申请的用于确定患者风险的方法包括：获取进入医疗机构的患者的患者信息，患者信息包括患者描述信息，诊断信息和生理信息，根据生理信息确定患者分数，并且同时根据患者描述信息，诊断信息和患者评分，通过电路确定患者的患者发病风险和患者死亡风险。根据生理信息确定患者得分还可以包括识别患者描述信息，诊断信息和生理信息的数值，以及通过计算数值来确定患者得分。